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British Standards Institution
Report.

No. 29—1909.

British Engineering Standards Association.

(*Incorporated 1918.*)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE
BY
THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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BRITISH STANDARD SPECIFICATION FOR INGOT STEEL FORGINGS FOR MARINE PURPOSES.

(REVISED NOVEMBER 1909.)

LONDON:
PUBLISHED FOR THE ASSOCIATION BY CROSBY LOCKWOOD & SON,
7, STATIONERS' HALL COURT, LUDGATE HILL, E.C. 4; AND 5, BROADWAY, LONDON, S.W. 1,
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October, 1918.

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MR. C. LE MAISTRE (*Secretary*).

MR. CHARLES DRESSER (*Assistant Secretary*).

* Succeeded the late SIR JOHN WOLFE BARRY, K.C.B., February 1918.

BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following are lists of Members of the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery, and of the Sub-Committee on Castings and Forgings for Marine Work, who have had the revision of this Specification under consideration.

◆

SECTIONAL COMMITTEE ON SECTIONS AND TESTS FOR MATERIALS USED IN THE CONSTRUCTION OF SHIPS AND THEIR MACHINERY.

November, 1909.

Chairman, MR. ARCHIBALD DENNY.
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Board of Trade, Mr. A. Boyle.
Institution of Naval Architects, *Mr. James Dunn; Mr. W. J. Pratten.
Iron and Steel Institute, Mr. Arthur Cooper.
Institution of Engineers and Shipbuilders in Scotland, Mr. Alex. M. Kennedy; Mr. Alexander Gracie, M.V.O.
North-East Coast Institution of Engineers and Shipbuilders, Mr. Henry Withy; Mr. Summers Hunter.
Steel Ingot Makers' Association, *Mr. David Colville; Mr. Maxmilian Mannaberg.
English and Scottish Forge Masters' Association, Mr. A. D. Wedgwood.
Steel Forging Makers' Association, *English and Scottish Steel Founders' Association* } Mr. Bernard A. Firth.
Lloyds' Register of British and Foreign Shipping, *Mr. Samuel J. P. Thearle; Mr. J. T. Milton.
British Corporation for the Survey and Registry of Shipping, Mr. J. Foster King.
Bureau Veritas, Mr. John Gravell.
South Staffordshire Ironmasters' Association, *Sir George Hingley, Bart.
North of England Iron and Steel Manufacturers' Association, *Mr. William Thackray.
Scottish Iron Manufacturers' Association, Mr. William Wylie.
Mr. R. J. Butler, C.B. (*John Spencer & Sons, Ltd.*); Mr. James McKechnie (*Vickers, Sons & Maxim Ltd.*); Mr. Thomas Putnam (*Darlington Forge Co. Ltd.*); *Mr. J. Hamilton Turner (*P. & W. MacLellan, Ltd.*); Mr. John Watson (*Steel Company of Scotland*); Prof. W. C. Unwin.

* Since deceased.

SUB-COMMITTEE ON STEEL CASTINGS AND FORGINGS FOR MARINE WORK.

November, 1909.

Chairman, MR. HENRY WITHY.
Mr. A. Denny (*ex officio*).
Admiralty, Engineer-Commander Philip Marrack, R.N.; Mr. W. E. Smith, C.B.
Board of Trade, Mr. A. Boyle.
Lloyds' Register of British and Foreign Shipping, *Mr. Samuel J. P. Thearle; Mr. J. T. Milton.
British Corporation for the Survey and Registry of Shipping, Mr. J. Foster King.
Bureau Veritas, Mr. John Gravell.
Steel Forging Makers' Association, *English and Scottish Steel Founders' Association* } Mr. Bernard A. Firth.
English and Scottish Forge Masters' Association, Mr. A. D. Wedgwood.
Mr. R. J. Butler, C.B. (*John Spencer & Sons, Ltd.*); Mr. Thomas Putnam (*Darlington Forge Co., Ltd.*); Mr. John Watson (*Steel Co. of Scotland, Ltd.*).

* Since deceased.

PREFACE TO FIRST EDITION.

The Sectional Committee on Ships Sections was appointed by the Main Committee on July 19th, 1901.

Having in conjunction with the Sectional Committee on Bridges, and the Sectional Committee on Railway Rolling Stock Underframes, completed the Standard Lists of Rolled Sections for Structural Purposes, the Committee next dealt with Standard Specifications for Steel and Iron Material used in Shipbuilding. For this purpose the Committee was considerably enlarged, and has held in all twelve meetings.

The appointment of a small Sub-Committee, consisting of representatives of the Admiralty, the Board of Trade, the three Registry Societies, the English and Scottish Forge Masters' Association, the Steel Forging Makers' Association, and the English and Scottish Steel Founders' Association, to draw up Specifications for Steel Castings and Forgings for Marine Work, was approved by the Main Committee on June 9th, 1904. The present Specifications of the Admiralty, the Board of Trade, and the three leading Registry Societies, were carefully compared, and from these a draft Specification was prepared, submitted to the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery, and adopted by them at their meeting on February 7th, 1907.

This Report was approved by the Main Committee at their meeting on March 7th, 1907.

A. DENNY,

Chairman of the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery.

PREFACE TO SECOND EDITION.

The following revisions were made to this Specification at the annual meeting of the Sectional Committee on Sections and Tests for Material used in the Construction of Ships and their Machinery held on July 2nd, 1909.

In regard to the number of tensile tests required, an additional provision has been made to the effect that in the case of a number of small forgings, where the expense incurred in leaving test material on each is excessive, the Maker shall have the option of supplying for testing purposes additional forgings to the extent of 5 per cent. of the number ordered.

In regard to the additional tests before rejection the acceptance of a forging in the case of failure of the first test taken therefrom has been made to depend upon the success of two further similar tests, the acceptance or rejection of the forging being dependent upon the success or failure of two out of three tests.

The Specification in its present form was approved by the Main Committee at their meeting on October 27th, 1909.

A. DENNY,

Chairman of the Sectional Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery.

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
INGOT STEEL FORGINGS FOR MARINE PURPOSES.

(REVISED NOVEMBER, 1909.)

Process of Manufacture.

1. Ingot Steel for Forgings for Marine Purposes shall be made by the Open Hearth process, Acid or Basic, as may be specified, and as approved by the Inspecting Body.

The Forgings shall be made from sound ingots, and for all important Forgings (such as crank and propeller shafts, connecting rods, piston rods, crosshead pins, &c.), the Forgings must be gradually and uniformly forged. Not more than the lower two-thirds of the ingot is to be utilised for purposes of forging. The sectional area of the body of the Forging (as forged) shall not exceed one-fifth of the sectional area of the original ingot, and no part of the Forging (as forged) shall have more than two-thirds of the sectional area of the original ingot.

Freedom from Defect.

2. The Forgings must be sound, and must admit of being machined to the required dimensions. Defects in Forgings shall not be repaired by patching or electric welding, nor is the steel to be toughened, without the previous sanction of the Inspector.

Annealing.

3. All Ingot Steel Forgings for Marine Purposes shall be thoroughly annealed in a properly constructed annealing furnace, which must permit of the whole Forging being uniformly raised in temperature throughout its whole extent to the necessary intensity required for annealing purposes. If the Forging be subsequently heated for any further forging it shall again be similarly annealed, if required by the Inspector.

Testing and Inspection.

4. The following tests and inspections shall be made at the place of manufacture prior to despatch ; but in the event of any of the material proving unsatisfactory in the course of machining or erection, such material shall be rejected, notwithstanding any previous certificate of satisfactory testing.

Tensile and Bend Test Pieces.

5. The tensile strength and ductility shall be determined from test pieces of Standard dimensions (*see* Standard Tensile Test Piece **C** or **D,** Appendix, page 13, and the Bend Test Piece described in Clause 9), which are to be prepared from sample pieces cut lengthwise from the Forging from a part of not less sectional dimensions than the body of the Forging. Such Standard test pieces shall be machined from the sample piece without forging down, and the sample piece shall not be detached from the Forging until the annealing of such Forging has been completed. The test pieces are to be stamped by the Inspector after the annealing.

Mechanical Tests and Selection of Test Pieces.

6. Ingot Steel Forgings for Marine Purposes must comply with the following mechanical tests. All test pieces shall be selected by the Inspector and tested in his presence, and he shall satisfy himself that the conditions herein prescribed are fulfilled.

Tensile Tests.

7. The tensile strength of Ingot Steel Forgings for Marine Purposes, ascertained from Standard test pieces, must be between the extreme limits of 28 and 40 tons per square inch. In all cases a margin of 4 tons per square inch shall be allowed between the specified maximum and minimum tensile breaking strengths. The elongation, measured on a Standard test piece (**C** or **D,** *see* Appendix, page 13), must be not less than 29 per cent. for 28 ton steel and 17 per cent. for 40 ton steel, and in no case must the sum of the tensile breaking strength and corresponding elongation be less than 57.

Number of Tensile Tests.

8. The number of tensile tests from each Forging shall be as may be specified, but at least one tensile test shall be taken from each Forging.

Where a number of articles are cut from one Forging, one tensile test from this whole Forging will be sufficient, unless more are specified.

Where a number of small forgings is required and the expense incurred in leaving test material on each one is excessive, it shall be optional with the Manufacturer to supply at his own cost additional forgings to the number of not more than 5 per cent. of the order, and the Inspector shall select haphazard from the bulk, for testing as representing the whole, such forgings as he may consider necessary up to the extent of such extra number.

Bend Tests.

9. Cold bend tests shall be made upon test pieces having a rectangular section of 1 inch wide × $\frac{3}{4}$ inch thick. The test pieces shall be machined and the edges rounded to a radius of $\frac{1}{16}$ inch. The test pieces shall be bent over the thinner section.

Bend tests may be made by pressure or by blows.

The test pieces must withstand, without fracture, being bent through an angle of 180 degrees, the internal radius of the bend being not greater than that specified below.

Maximum Specified Tensile Strength of Forging.	Internal radius of Test Piece after Bending.
	inch.
32 tons per sq. in.	$\frac{1}{4}$
Above 32 and up to 36 tons per sq. in.	$\frac{3}{8}$
,, 36 ,, 40 ,, ,,	$\frac{5}{8}$

Number of Bend Tests.

10. The number of bend tests from each Forging shall be as may be specified, but at least one bend test shall be taken from each Forging.

Where a number of articles are cut from one Forging, one bend test from this whole Forging will be sufficient, unless more are specified.

Where a number of small forgings is required and the expense incurred in leaving test material on each one is excessive, it shall be optional with the Manufacturer to supply at his own cost additional forgings to the number of not more than 5 per cent. of the order, and the Inspector shall select haphazard from the bulk, for testing as representing the whole, such forgings as he may consider necessary up to the extent of such extra number.

Additional Tests before Rejection.

11. Should either a tensile or bend test fail to fulfil the test requirements, and the Inspector agrees that the test piece does not fairly represent the quality of the material, two duplicate specimens may, if the Maker wishes, be tested, and if the results obtained from both are satisfactory, the quality of the material shall be judged therefrom, and not from the original test which failed. If, however, either of the duplicate tests fails, the material represented shall be rejected.

Branding.

12. Every Forging manufactured to this Specification shall, after it has satisfactorily withstood the prescribed tests, be clearly and distinctly marked with an approved quality brand, indicating that the material has complied with the Standard tests.

All Forgings shall be legibly marked with number or identification marks by which they can be traced to the charge from which the material was made.

APPENDIX.

FORMS

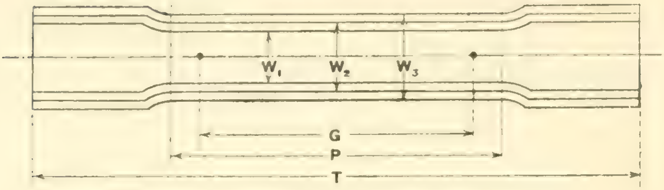
OF

BRITISH STANDARD TENSILE TEST PIECES.

APPENDIX.

FORMS
OF
BRITISH STANDARD TENSILE TEST PIECES.

TEST PIECE **A.**

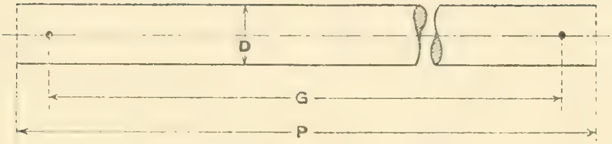


Gauge Length **G** = 8 inches.
Parallel Length **P** to be not less than 9 inches.
Total Length **T** = About 18 inches.

Thickness of Test Piece.	Maximum Width allowed.
Over $\frac{7}{8}$ in. (0·875 in.)	$\mathbf{W}_1 = 1\frac{1}{2}$ ins.
$\frac{3}{8}$ in. (0·375 in.) to $\frac{7}{8}$ in (0·875 in.)	$\mathbf{W}_2 = 2$ ins.
Under $\frac{3}{8}$ in. (0·375 in.)	$\mathbf{W}_3 = 2\frac{1}{2}$ ins.

The widths of the test pieces for plates were selected to comply with the two following conditions. (1) As the great bulk of plates to be tested are from $\frac{3}{8}$ inch to $\frac{7}{8}$ inch thick, it was desirable for the sake of convenience that the test pieces for such plates should be of uniform width, and, in accordance with very general practice, a width of 2 inches was selected. (2) With a test piece of a given form, the percentage of elongation was found to be less for thick plates than for thin ones; with steel of the same quality in other respects it was desirable therefore to choose widths of test piece which would be slightly in favour of the thicker plates. This is secured with the widths selected for the Standard Test piece of form **A.**

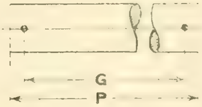
TEST PIECE **B.**



Gauge Length **G** to be not less than 8 times the diameter **D.**
With enlarged ends :—Parallel Length **P** to be not less
than 9 times the reduced diameter **D.**

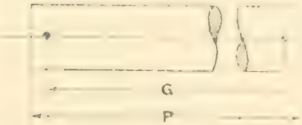
All test pieces of form **B** are strictly similar, and for the same material give the same percentage of elongation. They are nearly similar to a test piece of form **A,** 8 inches in gauge length, 2 inches wide and $\frac{3}{8}$ inch thick.

TEST PIECE **C.**



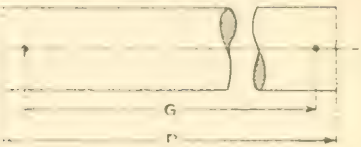
Gauge Length **G** = 2 inches.
Parallel Length **P** to be not less than $2\frac{1}{4}$ inches.
Dia. = 0·564 inch.
Area = $\frac{1}{4}$ sq. inch.

TEST PIECE **D.**



Gauge Length **G** = 3 inches.
Parallel Length **P** to be not less than $3\frac{3}{8}$ inches.
Dia. = 0·798 inch.
Area = $\frac{1}{2}$ sq. inch.

TEST PIECE **E.**

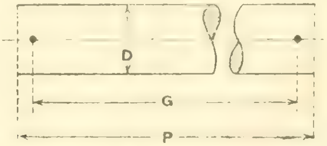


Gauge Length **G** = $3\frac{1}{2}$ inches.
Parallel Length **P** to be not less than 4 inches.
Dia. = 0·977 inch.
Area = $\frac{3}{4}$ sq. inch.

Test pieces **C, D,** and **E** were arranged to meet the very common practice of making test pieces for forgings, axles, tyres, etc., of either $\frac{1}{4}$ square inch or $\frac{1}{2}$ square inch in sectional area. With the gauge lengths decided upon, these three forms are very nearly similar, and, for a given material, give very approximately the same percentage of elongation. Though not exactly, they are approximately similar to the Standard Test Piece **F,** and for the same material give a nearly identical, but slightly greater, percentage of elongation.

TEST PIECE **F.**

(For Test Pieces over 1 inch diameter.)



Gauge Length **G** to be not less than 4 times the diameter **D**.
With enlarged ends:—Parallel Length **P** to be not less than $4\frac{1}{2}$ times the reduced diameter **D**.

In some testing machines it was found inconvenient to use form **B** for bars of over 1 inch in diameter, and form **F** of half the gauge length is designed to meet such cases. For a given material the percentage of elongation with test piece **F** is greater than with test piece **B,** and this difference is provided for in the British Standard Specifications.

FORM OF ENDS.

In the case of the round test pieces **B, C, D, E** and **F,** the form of the ends is to be as required in order to suit the various methods employed for gripping the test piece. When enlarged ends are used the length of the parallel portion of the test piece must in no case be less than that noted on the diagrams.

British Engineering Standards Association.

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APRIL, 1919.

(*This List cancels all previous Lists.*)

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